sampling on a systematic grid, in conjunction with scanning, are used to assure that any small areas of elevated radioactivity that might remain within a Class 1 survey units will not produce a dose in excess of the release criterion. To accomplish this, an additional step in the survey design optimization is required.

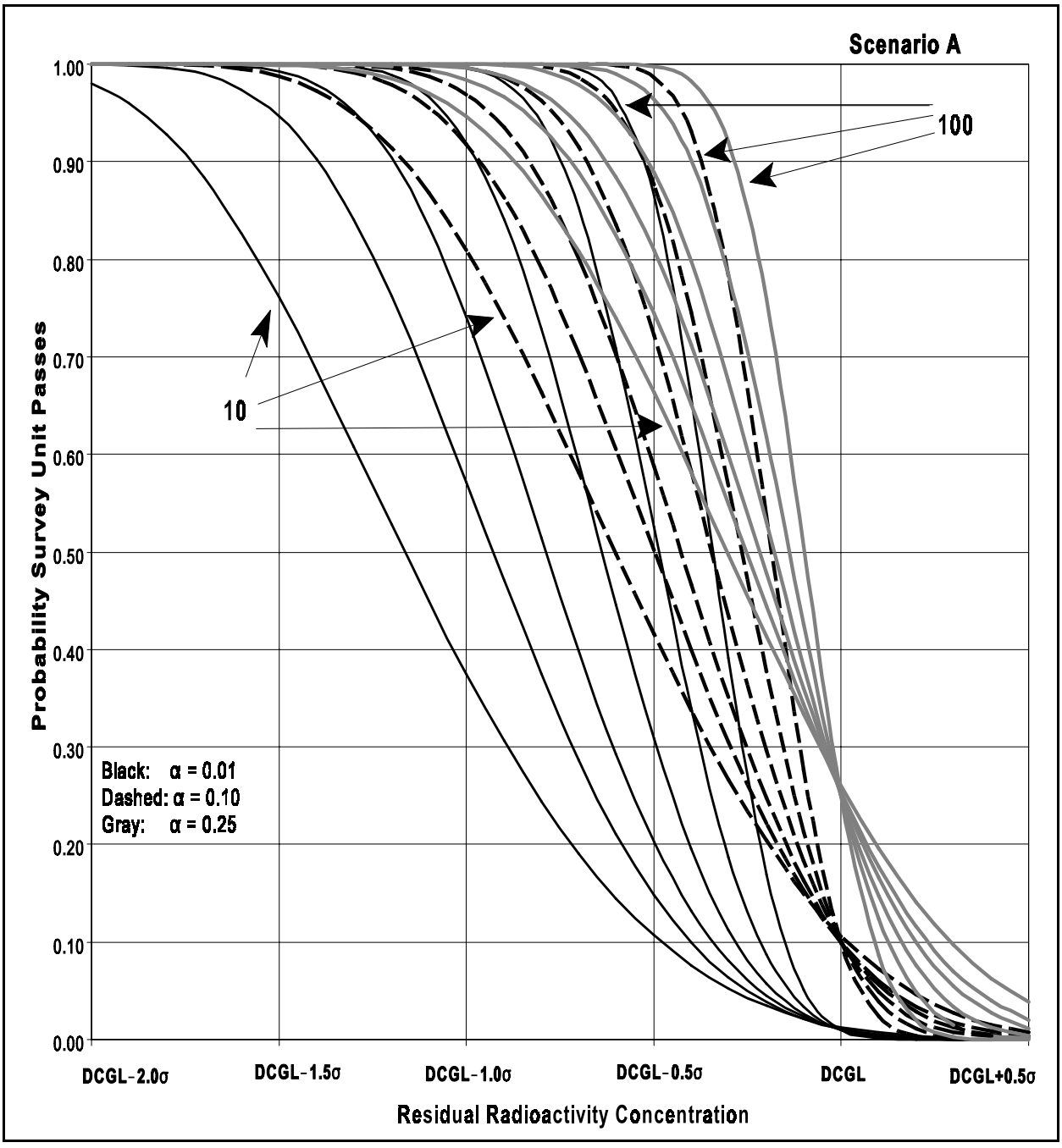

Figure 3.11 Probability a Survey Unit Is Released Using WRS Test Under Scenario A

The number of samples, *N*, to be taken on a random start systematic grid in a survey unit of area *A*, determines the spacing, *L*, between the samples (see Section 3.4.5). Corresponding to this spacing is the grid area delimited by neighboring sampling locations. This grid area is 0.866 L^2 for a triangular grid and L^2 for a square grid.

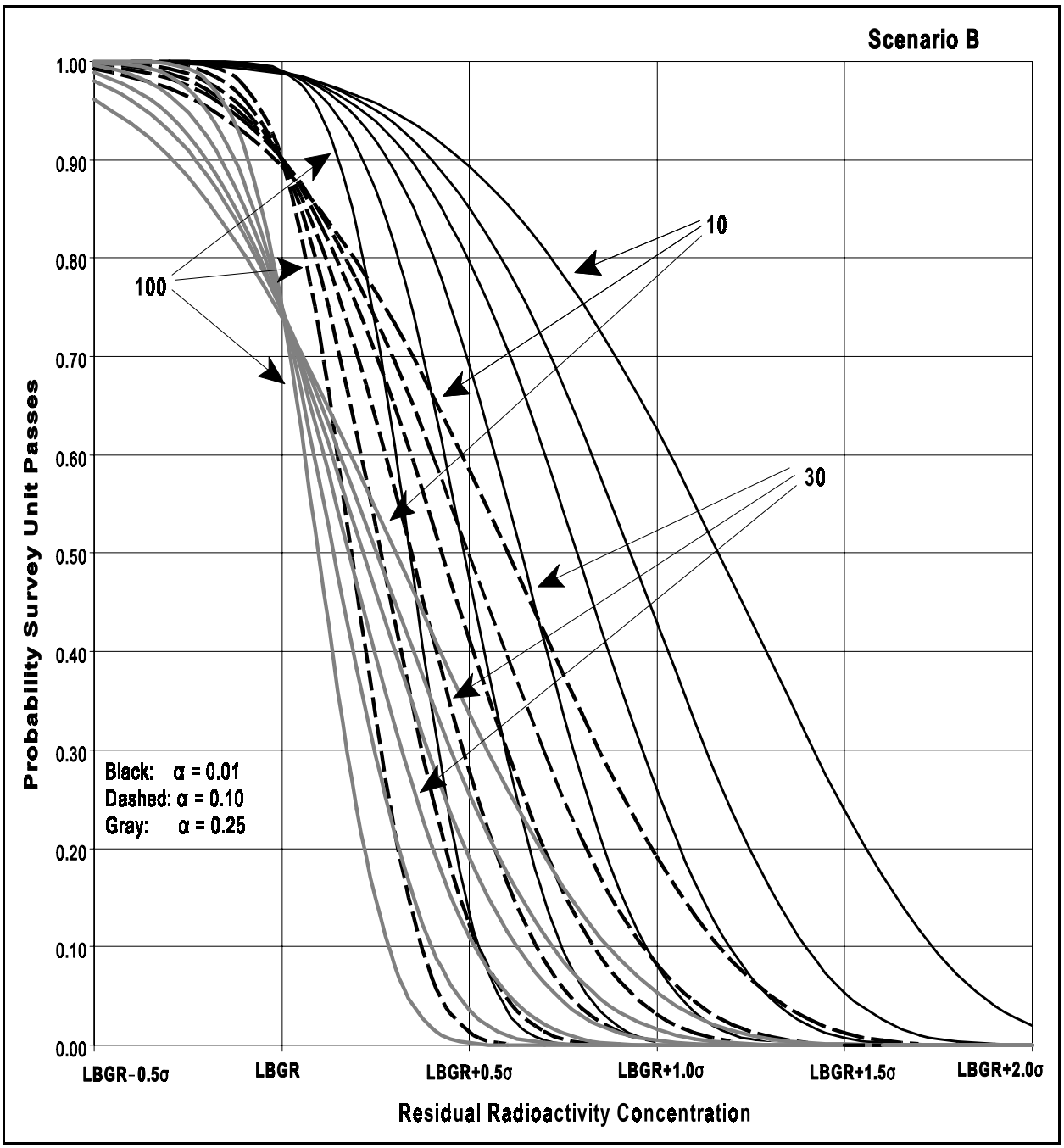

Figure 3.12 Probability a Survey Unit Is Released Using WRS Test Under Scenario B

A given concentration of residual radioactivity spread over a smaller area will, in general, result in a smaller dose. Thus, the $DCGL_{EMC}$ used for the elevated measurement comparison is usually larger than the $DCGL_W$ used for the statistical test. The amount of residual radioactivity that would have to exist within the grid area between sampling locations in order to exceed the guideline dose is a multiple, F_A, of the residual radioactivity derived concentration guideline level, $DCGL_W$. Values for the area factor, F_A, can be determined by comparing the dose conversion factor (DCF) obtained from the results of a pathway analysis under the scenario that a unit activity concentration of a given radionuclide is distributed uniformly across the survey unit

to the DCF obtained when a unit concentration of that radionuclide is confined to the smaller grid area. For some radionuclides, especially those that deliver dose primarily via internal pathways, the dose is approximately proportional to inventory, and so the ratio of the $DCGL_{EMC}$ to the $DCGL_W$ is nearly proportional to the ratio of the survey unit area to the grid area. However, this may not be the case for radionuclides that deliver a significant portion of the dose via external exposure. The exact relationship between the $DCGL_{EMC}$ and the $DCGL_W$ is generally a complicated function of the dose modeling pathways.

The scanning procedure used for the survey unit should have a minimum detectable concentration (MDC) less than the $DCGL_{EMC}$. The $DCGL_{EMC}$ depends on the grid area which in turn depends on the spacing of the samples. Once a scanning technique is selected, the actual MDC can be compared to the $DCGL_{EMC}$. If the actual scan MDC is less than the $DCGL_{EMC}$, the survey design is complete. When the scanning method is sensitive enough to detect residual radioactivity concentrations at the $DCGL_{EMC}$, the combination of sampling and scanning will be sufficient to provide reasonable assurance that release criterion is met by any residual radioactivity remaining in the survey unit. Any area smaller than the grid area would require a residual radioactivity concentration within it larger than $DCGL_{EMC} = (F_A)(DCGL_W)$ in order to exceed the release criterion. Recall from the discussion in Section 3.7.2 that any area larger than the grid area is likely to be hit by a sampling location on the systematic grid at least once.

If the scanning MDC is greater than the $DCGL_{EMC}$, then the survey design must be modified. A larger $DCGL_{EMC}$ is generally obtained by decreasing the sampling grid area, i.e., adding more sampling locations to the grid. The number of additional sampling locations can be found by determining the area factor necessary to raise the $DCGL_{EMC}$ to a level detectable by scanning:

$F_A = (Scan\ MDC) / (DCGL_W)$.

The sampling grid area, A_{MDC} , that corresponds to this area factor can be used to determine the sample size for the survey unit. Dividing the survey unit area, A_S , by the revised sampling grid area A_{MDC} yields the required sample size, $n_{MDC} = A_S / A_{MDC}$.

Thus, for Class 1 Survey Units, the number of samples may be driven more by the need to detect small areas of elevated activity than by the requirements of the statistical tests. This in turn will depend primarily on the sensitivity of available scanning instrumentation, the size of the area of elevated activity, and the dose model. For many radionuclides, scanning instrumentation is readily available that is sensitive enough to detect residual radioactivity concentrations at the $DCGL_{EMC}$ derived for the sampling grid of direct measurements used in the statistical tests. Where instrumentation of sufficient sensitivity is not available, the number of samples in the survey unit can be increased until the area between sampling points is small enough (and the resulting area factor is large enough) that $DCGL_{EMC}$ can be detected by scanning. For some radionuclides (e.g., ^3H), the scanning sensitivity is so low that this process would never terminate—i.e., the number of samples required could increase without limit. Thus, an important part of the DQO process is to determine the smallest size of an area of elevated activity that it is important to detect, A_{min} , and an acceptable level of risk , R_A , that it may go undetected. Figures 3.7 and 3.8 can be used for this purpose. The ELIPGRID-PC computer code (ORNL/TM-12774, 1994) can also be used to calculate these risks.

In this part of the DQO process, the concern is less with areas of elevated activity that are found than with providing adequate assurance that negative scanning results truly demonstrate the absence of such areas. In selecting acceptable values for A_{min} and R_A, maximum use of information from the historical site assessment and all surveys prior to the final status survey should be used to determine what sort of areas of elevated activity could possibly exist, their potential size and shape, and how likely they are to exist.